

X-ray  
Observations  
of the Vela  
SNR Ejecta  
Fragments

T. Gaetz

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Fragment D:  
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# X-ray Observations of the Vela SNR Ejecta Fragments

T. J. Gaetz

Smithsonian Astrophysical Observatory

Local Bubble and Beyond II  
2008 Apr 22

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# Collaborators

(Work in progress)

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M. Havercorn (NRAO/UC Berkeley)

R. Sankrit (UC Berkeley)

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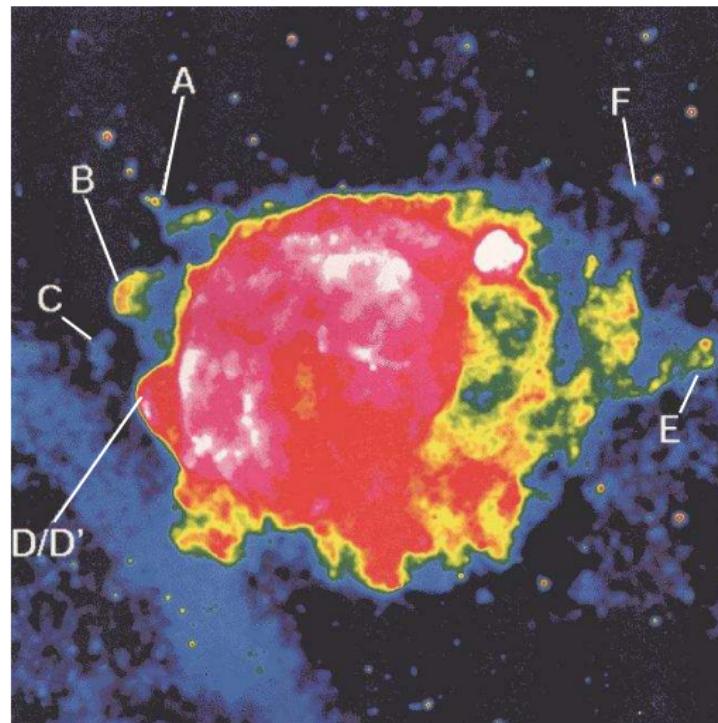
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# RASS image



# The VELA SNR

## Distance & Age

- One of the nearest SNRs
- Large in angular size ( $\sim 8^\circ$ )
- X-rays
  - bright in the N & E; bright eastern rim
  - faint, ragged W & S
  - associated pulsar; PWN
- Also visible in UV

# The VELA SNR

## Distance & Age

- Distance:

- $250 \pm 30$  pc [Cha et al. 1999]  
(high resolution absorption spectroscopy)
- $294^{+76}_{-50}$  pc [Carveo et al. 2001]  
(HST/WFPC-2; pulsar parallax)

- Age:

- 11400 yr [Taylor et al. 1993]  
(spin-down rate of the pulsar)
- $\sim 20000\text{--}30000$  yr (?) [Lyne et al. 1996]  
(pulsar spin-down; very low braking index)
- $18000 \pm 9000$  yr [Aschenbach et al. 1995]  
(offset from apparent center based on the “bullets” + proper motion of pulsar)

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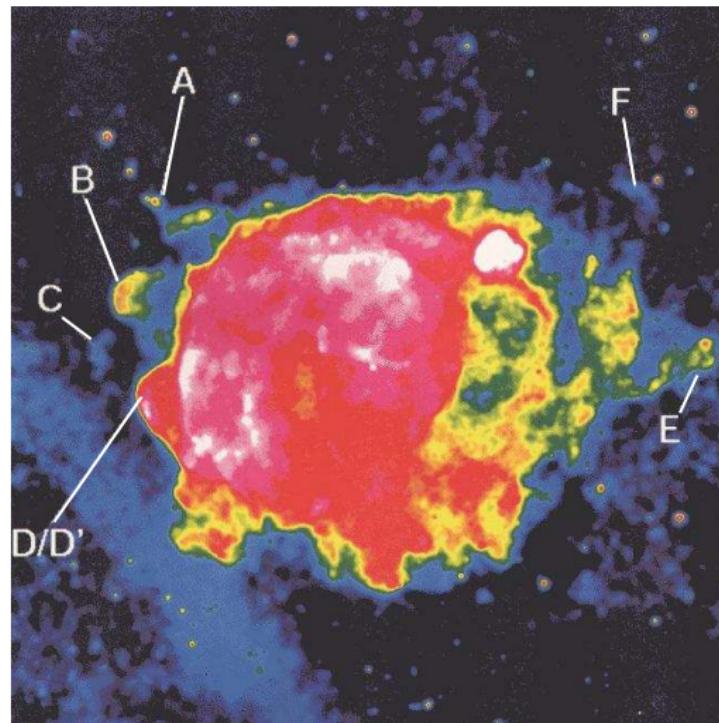
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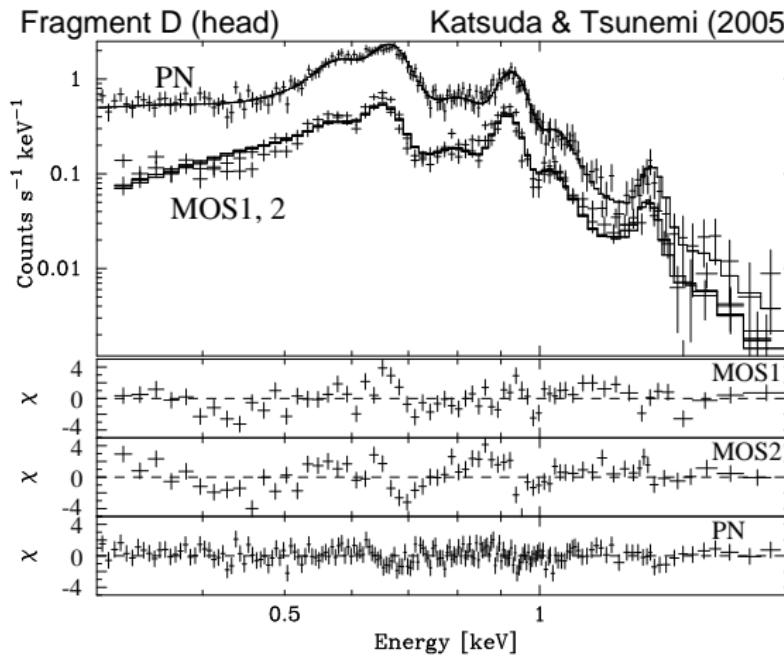


# Vela SNR ejecta fragments

- Aschenbach et al. (1995) identified 6 “fragments” A – F
  - fragments resemble bow shocks from projectiles;  
suggested ejecta fragments
  - B, C, D, F broad distributions; A & E more condensed.
  - Ejecta nature:
    - Plucinsky et al. (2002) Chandra data: fragment D could be significantly enhanced in O & Ne, but NEI effects ? ... could be solar
    - Katsuda et al. 2005 (XMM-Newton) - confirm significant O, Ne, Mg overabundance
    - Fragment A: Chandra (Miyata et al. 2001),  
XMM-Newton (Katsuda et al. 2006) significant Si overabundance.
    - confirmed as ejecta, but very different abundances ...

# Vela fragment D

## XMM-Newton Observations



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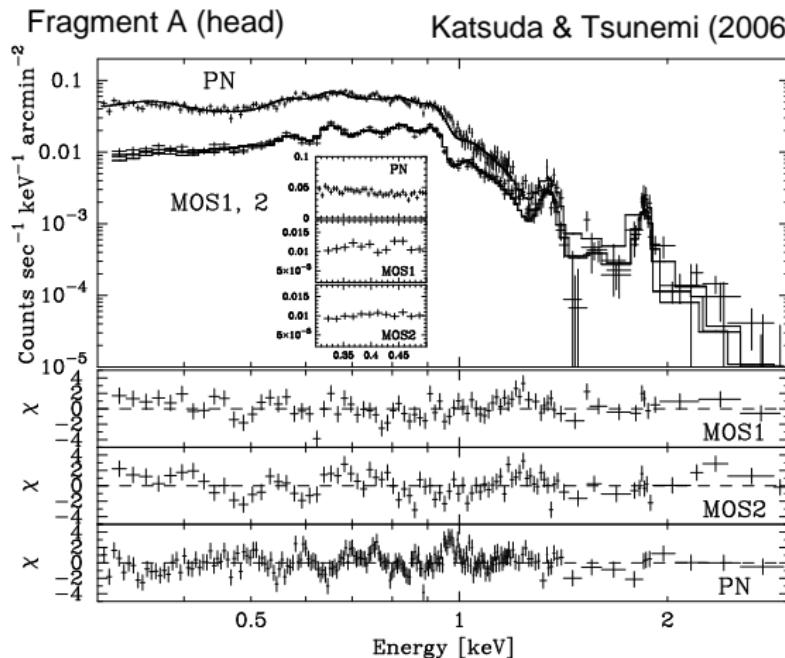
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# Vela fragment A

## XMM-Newton Observations



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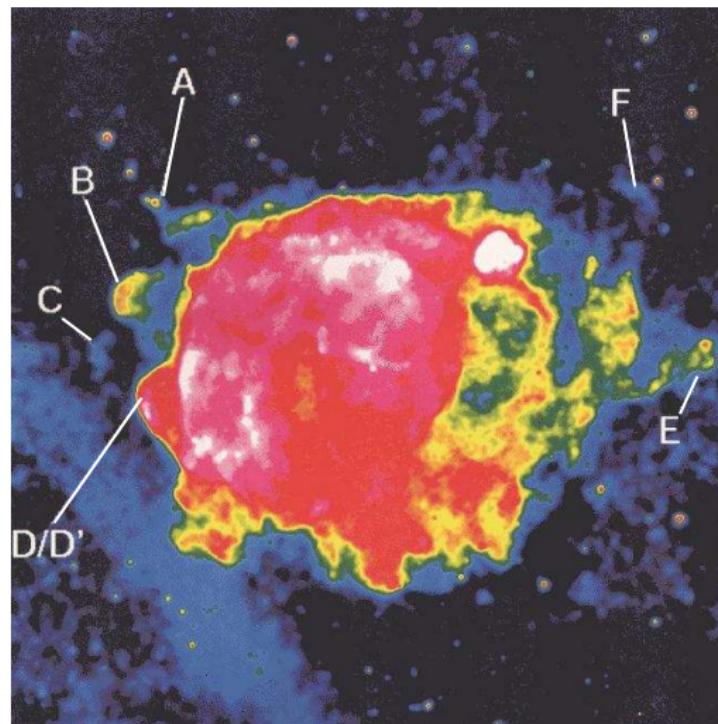
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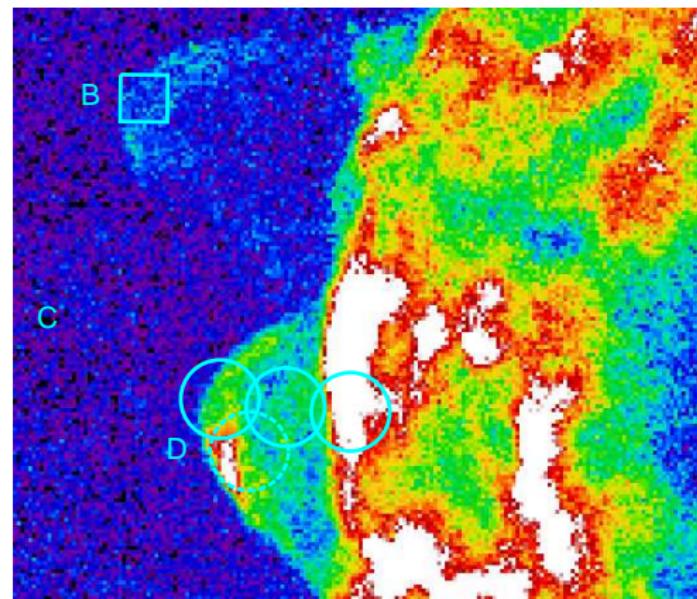
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# Vela fragment B



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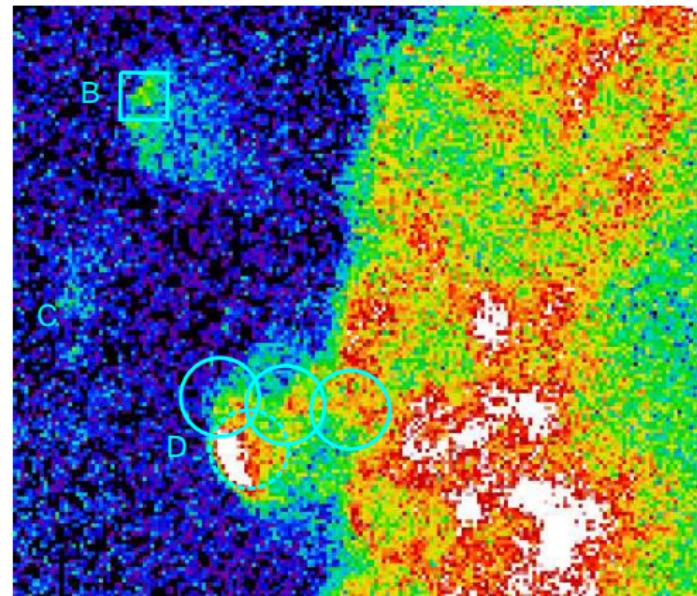
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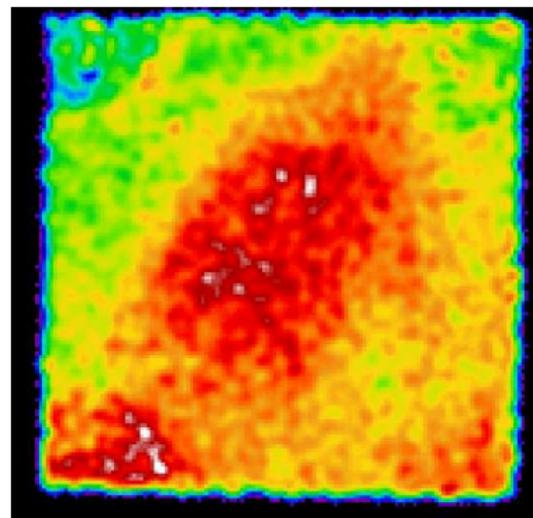
# Vela fragment B



# Vela fragment B

XIS0, XIS1, XIS2, XIS3 (exposure corrected)

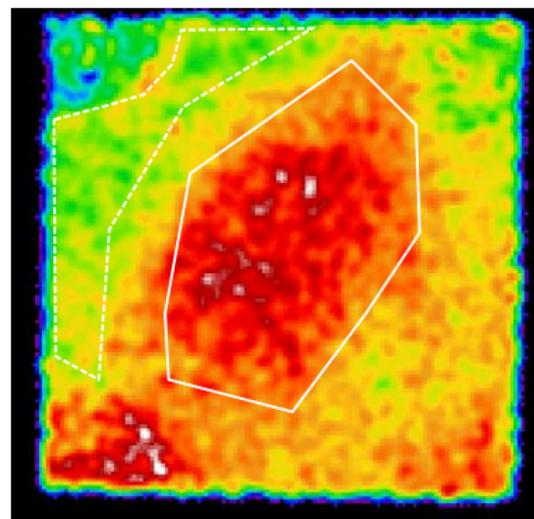
The rim of the “bullet” is clearly seen;  
more structure to the SW?



# Vela fragment B

XIS0, XIS1, XIS2, XIS3 (exposure corrected)

The rim of the “bullet” is clearly seen;  
more structure to the SW?

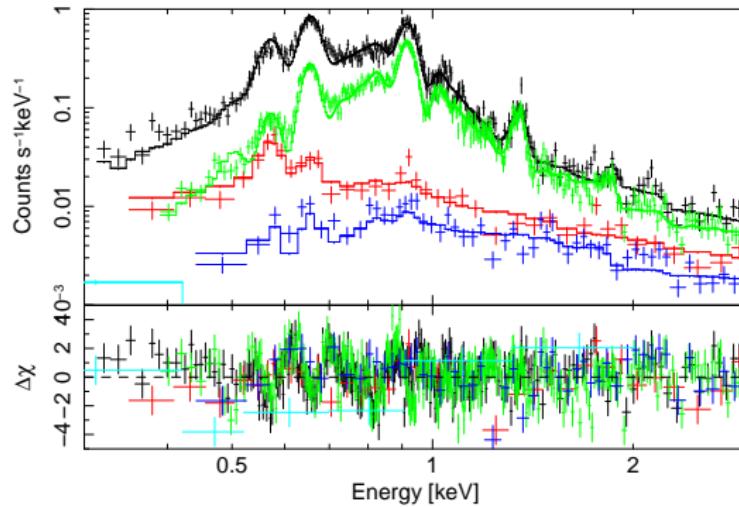


# Vela fragment B

Spectrum: XIS1, XIS0+XIS2+XIS3

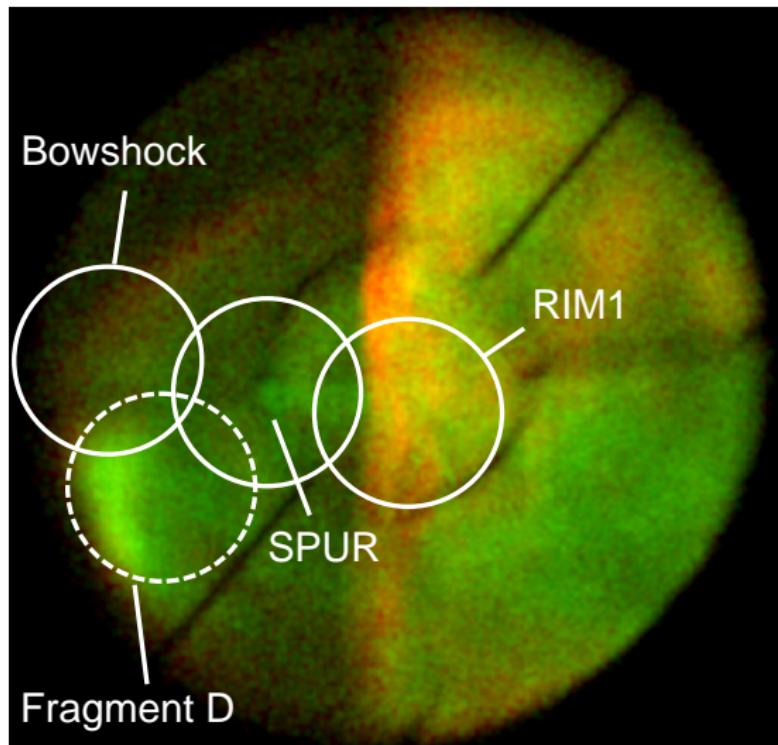
$$kT = 0.55, \log n_e t = 10.75$$

$$\text{O} = 3.1^{+1.8}_{-0.5}, \text{Ne} = 9.3^{+1.5}_{-2.4}, \text{Mg} = 5.7^{+0.4}_{-0.6}, \text{Si} = 3.5^{+0.8}_{-1.4}, \text{Fe}(\text{Ni}) = 3.2^{+1.1}_{-0.3}$$



# Vela fragment D

## Spatial Structure



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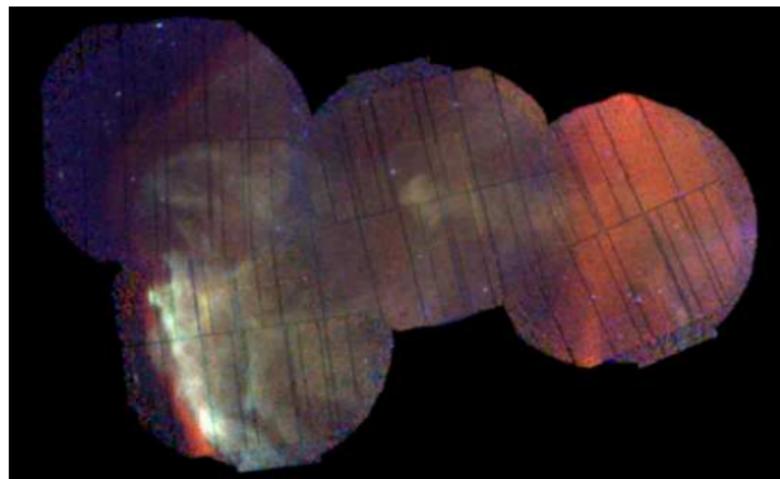
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# Vela fragment D

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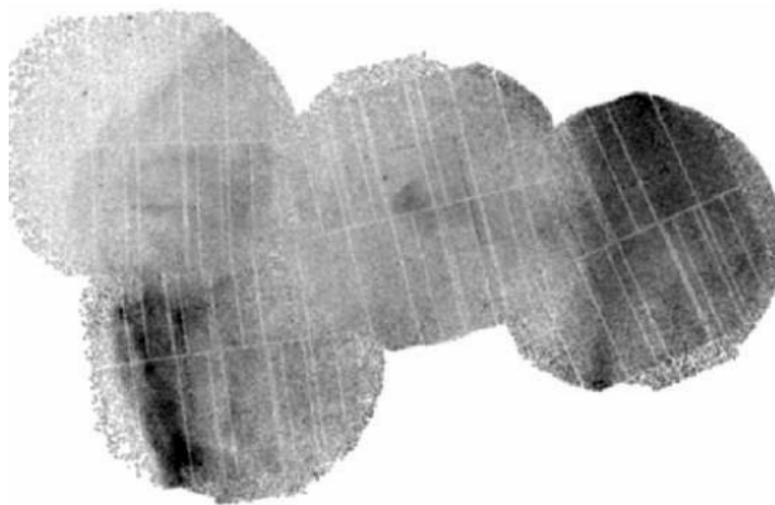
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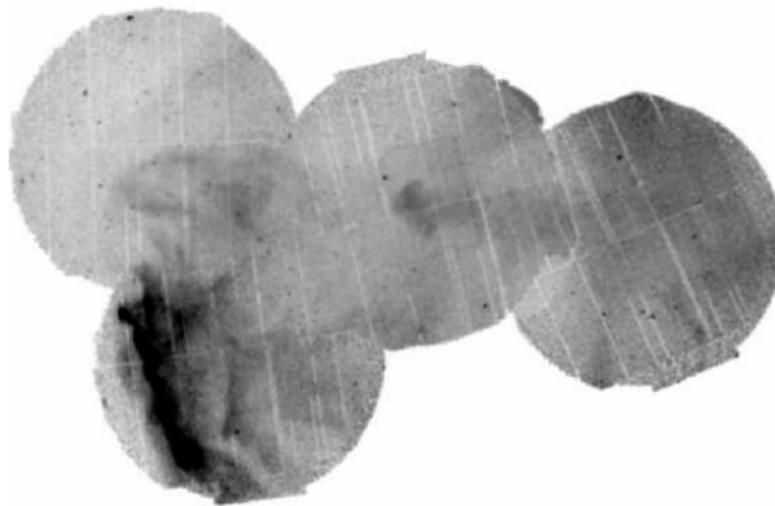
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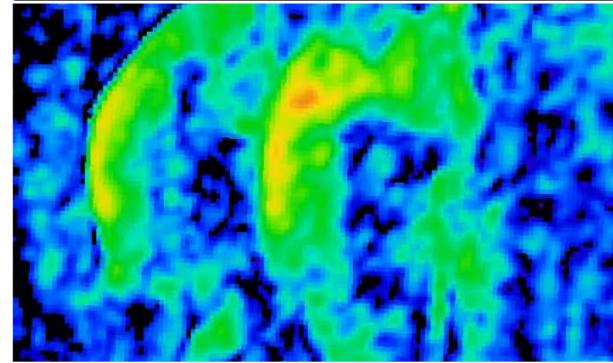
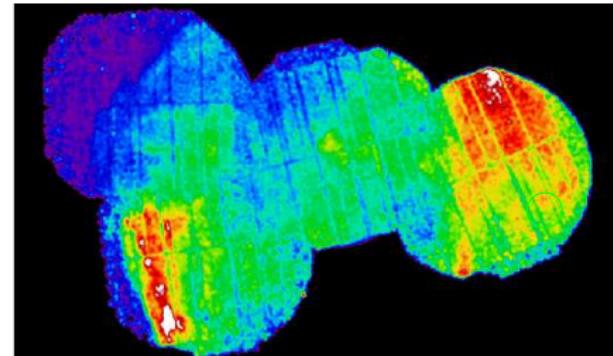
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# Vela fragment D

## -ray vs. Radio Polarization (SGPS)



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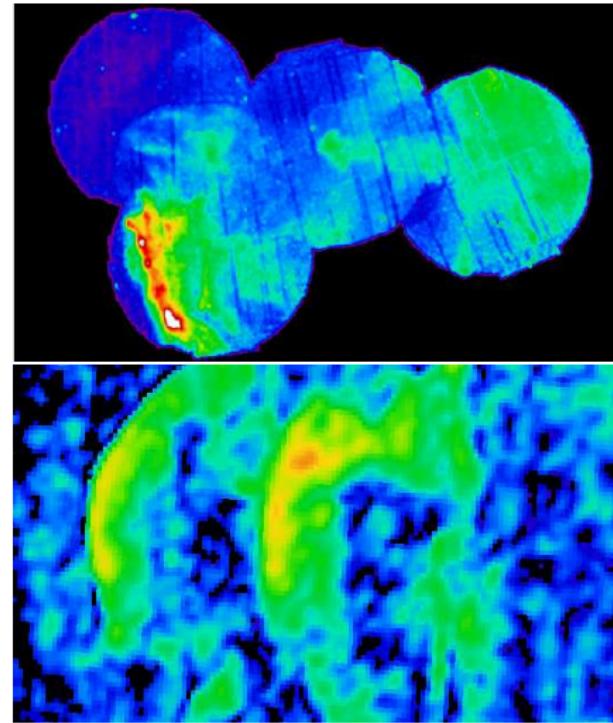
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# Vela fragment D

## -ray vs. Radio Polarization (SGPS)



# Summary

- Fragment A: Si-dominated;  
Fragments D & B: O, Ne, Mg
- Fragment D shows significant spatial structure:
  - Smooth, large scale structure in bright “head”; Rayleigh-Taylor? Kelvin-Helmholtz?
  - Significant substructure in wake (e.g., “spur”; sub-fragment or separate?)
  - bow shock structure
  - dominated by Ne, Mg, O throughout
- Coming up: Fragments C and E ?